Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 260

2004

Relationship of total iron content in beef to flavor attributes

J.P. Grobbel

Michael E. Dikeman

George A. Milliken

See next page for additional authors

Recommended Citation

Grobbel, J.P.; Dikeman, Michael E.; Milliken, George A.; and Yancey, E.J. (2004) "Relationship of total iron content in beef to flavor attributes," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.1663

Relationship of total iron content in beef to flavor attributes

Abstract

The objective of our study was to evaluate the relationships among total iron content, myoglobin/total iron ratio, hemoglobin/total iron ratio, and flavor attributes in beef top sirloin, shoulder clod, and tenderloin muscles. Top sirloin (n=74), shoulder clod (n=68), and tenderloin (n=73) muscles from A or B maturity carcasses that were either USDA Slight or USDA Small marbling and of either normal pH (<5.7) or high pH (>6.0) were vacuum packaged, aged 35 days at 35ºF, and stored at -4ºF until analysis. A well trained, flavorprofile sensory panel determined flavor attributes on charbroiled steaks. Flavor attributes included beef flavor identification, bloody/serumy, brown roasted, livery, metallic, rancid, and sour. Concentrations of myoglobin and hemoglobin were determined by using high-pressure liquid chromatography. Total iron concentration was determined by using an atomic absorption spectrophotometer. The shoulder clod had greater total iron (P<0.05) than the top sirloin or tenderloin. Livery flavor increased (P<0.05) and beef flavor identification and brown roasted flavor decreased (P<0.05) in the top sirloin as total iron increased. Compared with the top sirloin and shoulder clod, the tenderloin had lower (P<0.05) myoglobin/total iron ratios and greater (P<0.05) hemoglobin/total iron ratios. At medium and high myoglobin/total iron ratios, samples with Slight marbling had more (P<0.05) livery flavor. At low myoglobin/total iron ratios, A-maturity samples had more (P<0.05) rancid off-flavor than B maturity samples. There were no relationships between hemoglobin/total iron ratios and flavor attributes. Total iron may contribute to livery flavor in the top sirloin, but total iron is not a reliable indicator of livery flavor.

Keywords

Cattlemen's Day, 2004; Kansas Agricultural Experiment Station contribution; no. 04-242-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 923; Beef; Iron content; Flavor; Myoglobin and hemoglobin concentrations

Authors

J.P. Grobbel, Michael E. Dikeman, George A. Milliken, and E.J. Yancey

RELATIONSHIP OF TOTAL IRON CONTENT IN BEEF TO FLAVOR ATTRIBUTES[1]

J. P. Grobbel, M. E. Dikeman, G. A. Milliken[2], E. J. Yancey[3]

Summary

The objective of our study was to evaluate the relationships among total iron content, myoglobin/total iron ratio, hemoglobin/total iron ratio, and flavor attributes in beef top sirloin, shoulder clod, and tenderloin muscles. Top sirloin (n=74), shoulder clod (n=68), and tenderloin (n=73) muscles from A or B maturity carcasses that were either USDA Slight or USDA Small marbling and of either normal pH ($\leq$5.7) or high pH (>6.0) were vacuum packaged, aged 35 days at 35ºF, and stored at -4ºF until analysis. A well trained, flavor-profile sensory panel determined flavor attributes on charbroiled steaks. Flavor attributes included beef flavor identification, bloody/serumy, brown roasted, livery, metallic, rancid, and sour. Concentrations of myoglobin and hemoglobin were determined by using high-pressure liquid chromatography. Total iron concentration was determined by using an atomic absorption spectrophotometer. The shoulder clod had greater total iron (P<0.05) than the top sirloin or tenderloin. Livery flavor increased (P<0.05) and beef flavor identification and brown roasted flavor decreased (P<0.05) in the top sirloin as total iron increased. Compared with the top sirloin and shoulder clod, the tenderloin had lower (P<0.05) myoglobin/total iron ratios and greater (P<0.05) hemoglobin/total iron ratios. At medium and high myoglobin/total iron ratios, samples with Slight marbling had more (P<0.05) livery flavor. At low myoglobin/total iron ratios, A-maturity samples had more (P<0.05) rancid off-flavor than B maturity samples. There were no relationships between hemoglobin/total iron ratios and flavor attributes. Total iron may contribute to livery flavor in the top sirloin, but total iron is not a reliable indicator of livery flavor.

Introduction

Livery flavor has been cited as a problem in beef top loin and tenderloin steaks by steak purveyors. The true cause of livery flavor is not completely understood. Previous research has found positive correlations (P<0.05) between myoglobin concentrations and livery flavor within the top sirloin, shoulder clod, and tenderloin. Although statistically significant, these correlations were somewhat small, and it may be that total iron may be related to livery flavor. Iron content in beef is relatively high and is greater in muscles in which livery flavor seems to be more prevalent. The objective of our study was to evaluate the relationships among total iron content, myoglo-

[1]This project was funded by beef and veal producers and importers through their $1-per-head checkoff and was produced for the Cattlemen's Beef Board and state councils by the National Cattlemen's Beef Association.

[2]Department of Statistics.
[3]Tyson Foods, Springdale, Arkansas.

bin/total iron ratio, hemoglobin/total iron ratio, and flavor attributes in beef top sirloin, shoulder clod, and tenderloin muscles.

Experimental Procedures

Samples. Top sirloin (n=74), shoulder clod (n=68), and tenderloin (n=73) muscles from either A- or B-maturity carcasses that were either USDA Slight^{00} to Slight^{50} (Select^{-}) or USDA Small^{00} to Modest^{00} (Choice^{-}) marbling and of normal pH ($\leq$5.7) or high pH ($\geq$6.0) were collected from two different commercial abattoirs at six different times. Samples were aged for 35 days at 35ºF in a vacuum package and then stored frozen (-4ºF) until analyses were completed.

Flavor Attributes. A well-trained, flavor-profile sensory panel evaluated charbroiled steaks for beef flavor identification, bloody/serumy, brown roasted, livery, metallic, rancid, and sour flavors.

Myoglobin and Hemoglobin Concentrations. High-pressure liquid chromatography was used to determine myoglobin and hemoglobin concentrations.

Total Iron Content. Duplicate 3.0- to 3.5-g, pulverized samples were weighed into ceramic crucibles and then ashed in a muffle furnace (model 85A, Neytech, Bloomfield, CT) at 1,112ºF for 4 hours. Samples were cooled to 68ºF and digested with 2.5N HCl for 50 minutes. Digested samples were diluted to 50 ml with distilled, deionized water and mixed. An atomic absorption spectrophotometer (AAnalyst 100, Perken Elmer, Norwalk, CT) was used to measure sample absorbance at 248.3 nm. Comparisons were made to a standard curve using 0, 1, 2, 5, and 10 ppm of iron to determine total iron content.

Statistical Analysis. The PROC MIXED procedure of SAS was used to analyze the data as a 3 x 2 x 2 x 2 factorial design with three muscles (top sirloin, shoulder clod, and tenderloin), two maturities (A and B), 2 pH levels ($\leq$5.7 and $\geq$6.0), and 2 marbling groups (USDA marbling scores of Slight^{00} to Slight^{50} (Select^{-}) and Small^{00} to Modest^{00} (Choice^{-})).

Results and Discussion

The shoulder clod had greater total iron ($P<0.05$) than the top sirloin or tenderloin (Table 1). Livery flavor increased ($P<0.05$, Table 2) and beef flavor identification (Table 3) and brown roasted flavor (Table 4) decreased ($P<0.05$) in the top sirloin as total iron increased. Compared with the top sirloin and shoulder clod, the tenderloin had lower ($P<0.05$) myoglobin/total iron ratios (Table 5) and higher ($P<0.05$) hemoglobin/total iron ratios (Table 6). At medium and high myoglobin/total iron ratios, samples with Slight marbling had more ($P<0.05$) livery flavor than those with Small marbling (Table 7). At low myoglobin/total iron ratios, A-maturity samples had more ($P<0.05$) rancid off-flavor than B maturity samples (Table 8). There were no relationships between hemoglobin/total iron ratios and flavor attributes. Total iron may contribute to livery flavor in the top sirloin muscle, but total iron is not a reliable indicator of livery flavor.

Table 1. Total Iron Concentration of Muscles

Muscle	Total Iron (ppm)	Standard Error
Top sirloin	21.39[a]	0.56
Shoulder clod	22.78[b]	0.58
Tenderloin	20.97[a]	0.60

[a,b]Means that have a different superscript differ (P<0.05).

Table 2. Livery Flavor for Different Levels of Total Iron

Muscle	Total Iron Level	Livery Flavor[a]	Standard Error
Top sirloin	Low	0.1[b]	0.13
Shoulder clod	Low	0.4[bc]	0.35
Tenderloin	Low	0.5[c]	0.47
Top sirloin	Medium	0.4[c]	0.06
Shoulder clod	Medium	0.3[c]	0.07
Tenderloin	Medium	0.3[c]	0.31
Top sirloin	High	0.6[c]	0.63
Shoulder clod	High	0.2[b]	0.15
Tenderloin	High	0.1[b]	0.10

[a]Scale for livery flavor (1=least intense, 15=most intense).
[b,c]Means having the same value for total iron and not having the same superscript letter differ (P<0.05).

Table 3. Beef Flavor Identification For Difference Levels of Total Iron

Muscle	Total Iron Levels	Beef Flavor Identification[a]	Standard Error
Top sirloin	Low	10.4[b]	0.13
Shoulder clod	Low	9.6[c]	0.16
Tenderloin	Low	10.2[b]	0.09
Top sirloin	Medium	10.0[c]	0.07
Shoulder clod	Medium	9.7[d]	0.07
Tenderloin	Medium	10.2[b]	0.06
Top sirloin	High	9.4[c]	0.17
Shoulder clod	High	9.9[b]	0.13
Tenderloin	High	10.2[b]	0.12

[a]Scale for beef flavor identification (1=least intense, 15=most intense).
[b,c,d]Means having the same value for total iron and not having the same superscript letter differ (P<0.05).

Table 4. Brown Roasted Flavor for Different Amounts of Total Iron

Muscle	Total Iron Level	Brown Roasted Flavor[a]	Standard Error
Top sirloin	Low	10.4[b]	0.14
Shoulder clod	Low	9.5[d]	0.16
Tenderloin	Low	10.0[c]	0.09
Top sirloin	Medium	10.1[c]	0.07
Shoulder clod	Medium	9.7[b]	0.07
Tenderloin	Medium	10.1[c]	0.05
Top sirloin	High	9.7[c]	0.17
Shoulder clod	High	9.9[bc]	0.13
Tenderloin	High	10.1[b]	0.12

[a]Scale for brown roasted flavor (1=least intense, 15=most intense).
[b,c,d]Means having the same value for total iron and not having the same superscript letter differ (P<0.05).

Table 5. Myoglobin/Total Iron Ratios

Muscle	Myoglobin/Total Iron	Standard Error
Top sirloin	0.183[b]	0.01
Shoulder clod	0.179[b]	0.01
Tenderloin	0.145[a]	0.01

[a,b]Means that have different superscripts differ (P<0.05).

Table 6. Hemoglobin/Total Iron Ratios

Muscle	Hemoglobin/Total Iron	Standard Error
Top sirloin	0.039[a]	0.002
Shoulder clod	0.043[a]	0.003
Tenderloin	0.067[b]	0.005

[a,b]Means that have different superscripts differ (P<0.05).

Table 7. Livery Flavor for Different Levels of Myoglobin/Total Iron

Marbling[1]	Myoglobin/Total Iron	Livery Flavor[a]	Standard Error
Select	Low	0.29[b]	0.07
Choice	Low	0.19[b]	0.07
Select	Medium	0.42[b]	0.06
Choice	Medium	0.20[c]	0.06
Select	High	0.55[b]	0.07
Choice	High	0.22[c]	0.07

[a]Scale for livery flavor (1=least intense, 15=most intense).
[b,c]Means having the same myoglobin/total iron and having different superscripts differ (P<0.05).

Table 8. Rancid Flavor for Different Levels of Myoglobin/Total Iron

Maturity[1]	Myoglobin/Total Iron	Rancid Flavor[a]	Standard Error
A	Low	0.58[b]	0.06
B	Low	0.33[c]	0.07
A	Medium	0.49[b]	0.05
B	Medium	0.37[b]	0.06
A	High	0.41[b]	0.06
B	High	0.42[b]	0.06

[a]Scale for rancid flavor (1=least intense, 15=most intense).
[b]Means having the same myoglobin/total iron and having different superscripts differ (P<0.05).